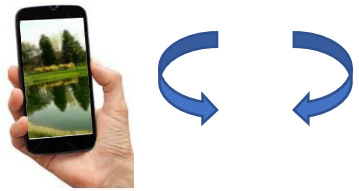
Summary

- Change of the World: from 3D to 2D
- How our brain works and changes
- Effects of the digital world on identity and relationship
- Effects of the digital world on free time and aggressivity
- **Effects of the digital world on memory and learning**

Conceptual map

IDENTITY and SOCIAL RELATIONSHIP

Change of the world



Change of the brain

FREE TIME

LEARNING

1) Memory →google effect

Google

2) Searching

3) Reading

4) Multitasking

Search information

Google

WIKIPEDIA

Google effect

- The present research explores whether **having online access to search engines** and **databases has become** a primary **transactive memory source in itself**.
- Authors designed 4 different experiments:

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Supporting Online Material
www.sciencemag.org/cgi/content/full/333/6043/773/DC1
Materials and Methods

Google Effects on Memory: Cognitive Consequences of Having Information at Our Fingertips

Betsy Sparrow,[1]* Jenny Liu,[2] Daniel M. Wegner[3]

EXPERIMENT 1

EXPERIMENT 2

EXPERIMENT 3

EXPERIMENT 4

Google effect

EXPERIMENT 1:

- participants were tested in two within-subject conditions
- they answered either easy or hard yes/no trivia questions in two blocks.

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Betsy Sparrow,[1]* Jenny Liu,[2] Daniel M. Wegner[3]

Question: Which is the capital of Karnataka?

Answer: …

Modified Stroop test to text RTs

SCREEN

PIZZA

Google effect

EXPERIMENT 1:

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- Each block was followed by a modified Stroop task to **test reaction times** to matched computer (e.g. presentation of wards such as “screen”, or “google”) and everyday terms.

→ **< RTs for naming the color of interested words**

SCREEN

PIZZA

Google effect

EXPERIMENT 1:

- Paired within-subject t tests were conducted on color-naming reaction times to computer and general words after the easy and difficult question blocks.

- **RESULTS**: **computer words were more accessible** then general words when participants had encountered a series of questions to which they did not know the answers
- **CONCLUSION**: It seems that when we are faced with a gap in our knowledge, we are primed to turn to the computer to rectify the situation. This effect is more robust for hard questions.

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Stroop test to text RTs

SCREEN

PIZZA

Google effect

EXPERIMENT 2:

- Authors tested whether people remembered information that they expected to have later access to
- Participants had to read 40 statements.
- Participants divided in 2 groups:
  - Half of them were led to believe the statements would be saved and available to look up later;
  - the other half were explicitly instructed to attempt to remember them.

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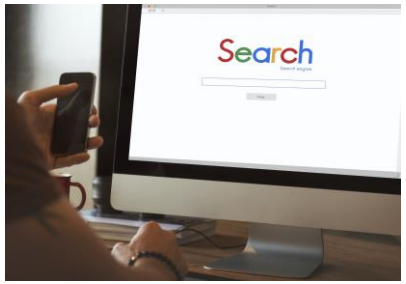
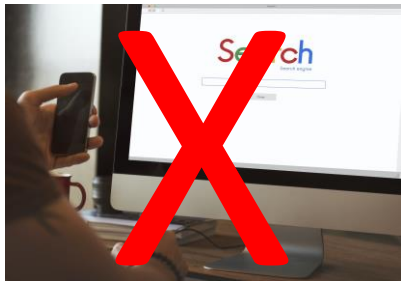
Betsy Sparrow,[1]* Jenny Liu,[2] Daniel M. Wegner[3]

Statement: The capital of Karnataka is Bangalore





erased conditions

Google effect

EXPERIMENT 2:

- **RESULTS**: **Participants** apparently **did not make the effort to remember when they thought they could later look up the trivia statements they had read**.
- **CONCLUSIONS**: Because search engines are continually available to us, we may often be in a state of not feeling we need to encode the information internally. When we need it, we will look it up.

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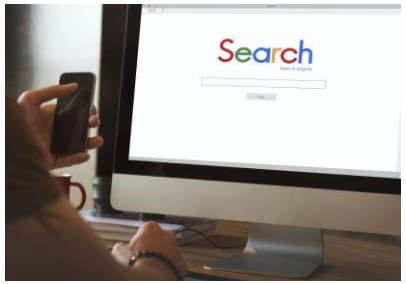

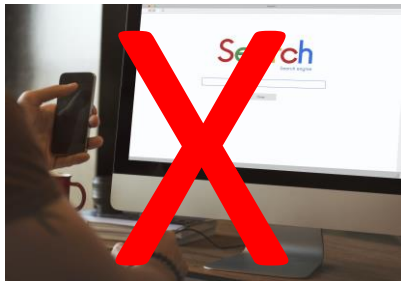

erased conditions

Google effect

EXPERIMENT 3:

- Authors tested memory for **where** to find information that one might look up online.
- Participants again red and typed in statements, this time in three within subject conditions:

1/3 questions → "Your entry has been saved in a general folder."

1/3 questions → "Your entry has been saved into the folder X"

1/3 questions → "Your entry has been erased."

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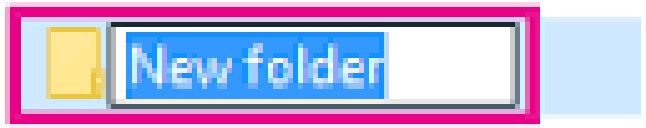

Google effect

EXPERIMENT 3:

- Recognition trial:

Participants had to **judge yes or no**

1) whether the statement they were now shown was exactly what they had read → *"Was this statement exactly what you read?"*

2) whether the statement had been saved or erased, and finally, → *Was this statement saved or erased?"*

3) if the statement had been saved to a folder, which folder it had been saved into → *If the information was saved, what folder was it saved into?"*

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Google effect

EXPERIMENT 3:

*"**Was this statement exactly what you read**?"*

RESULTS: Participants recognized the accuracy of a large proportion of statements**. But for those statements they believed had been erased, participants had the best memory.**

CONCLUSION: believing that one won't have access to the information in the future enhances memory for the information itself

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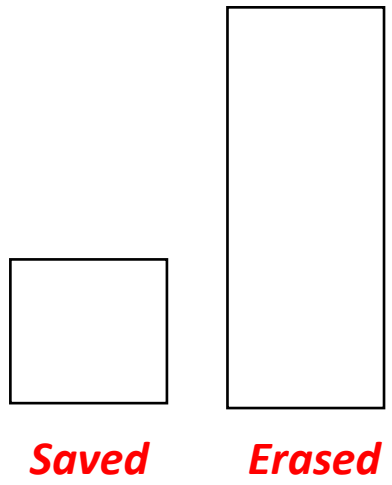

Google effect

EXPERIMENT 3:

"***Was this statement saved or erased?***"

RESULTS: Participants accurately remembered what they had saved more than they accurately remembered what they had erased.

CONCLUSION: believing the information was saved externally enhances memory for the fact that the information could be accessed, at least in general.

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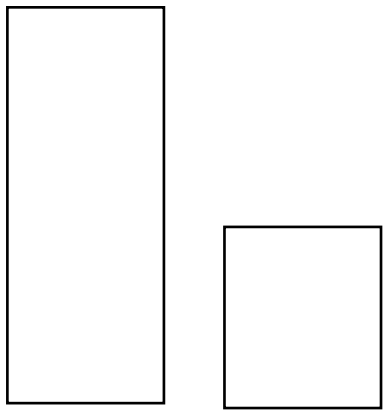

Google effect

EXPERIMENT 3:

"*If the information was saved, what folder was it saved into?"*

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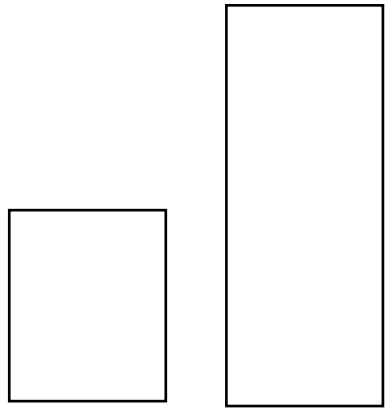
RESULTS: Participants **did remember more that the information was erased** than specifically whether the information was generally saved or which folder it was saved into.

CONCLUSION: This result is a reminder of the experience of remembering something you have read online that you would like to see again or share but **no longer remembering where you saw it** or what steps you took to find it in the first place, or even knowing that a file is saved onto your hard drive but having t use the search feature to find it



Google effect

EXPERIMENT 4:

- Was conducted to see if people would recall "**where**" to find information more than the information itself ("**what**")
- Participants believed all trivia statements that they typed would be saved into one of five generic folders

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Google Effects on Memory: Cognitive Consequences of Having Information at Our Fingertips

Betsy Sparrow,[1]* Jenny Liu,[2] Daniel M. Wegner[3]

Statement: The capital of Karnataka is Bangalore

Google effect

EXPERIMENT 4:

RESULTS:

- When asked to recall the folder names, they did so at greater rates than they recalled the trivia statements themselves.
- A deeper analysis revealed that **people do not necessarily remember where to find certain information when they remember what it was**, and that they particularly tend to remember where to find information when they can't remember the information itself.

CONCLUSION:

We adapt our memory to recall information (what or where).

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Google effect

- The Internet has become a primary form of external or transactive memory, where information is stored collectively outside ourselves.

- Google can “affect” memory… which kind of memory?

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Different memories

- **Nondeclarative** memory (or implicit or procedural memory)

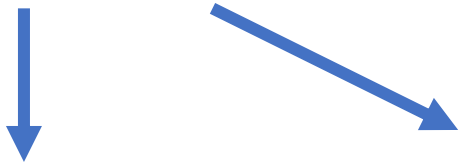
- **Declarative** (or explicit) memory
  - Episodic
  - **Semantic** Google Wikipedia

Googling

Your Brain on Google: Patterns of Cerebral Activation during Internet Searching

Gary W. Small, M.D., Teena D. Moody, Ph.D., Prabha Siddarth, Ph.D., Susan Y. Bookheimer, Ph.D.

- Using computer search engines to find information on the Internet has become a frequent daily activity of people at any age, including middle aged and older adults.
- Cross-sectional, exploratory observational study
- N = 24 (age 55-76)



N = 12 → Net Savvy group (more search engine experience)

N = 12 → Net Naive group (minimal search engine experience)

Googling

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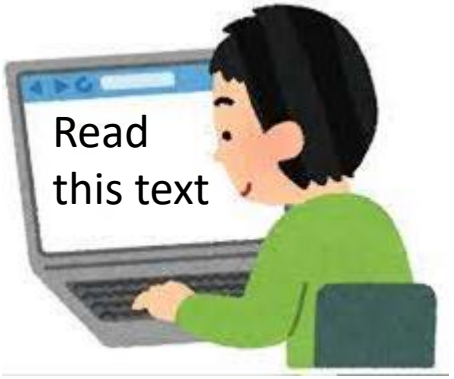
Gary W. Small, M.D., Teena D. Moody, Ph.D., Prabha Siddarth, Ph.D., Susan Y. Bookheimer, Ph.D.

- **Task**: Patterns of brain activation during functional MRI scanning were determined while subjects performed
  1. a novel Internet search task

2. or a control task of reading text on a computer screen formatted to simulate the prototypic layout of a printed book



Googling

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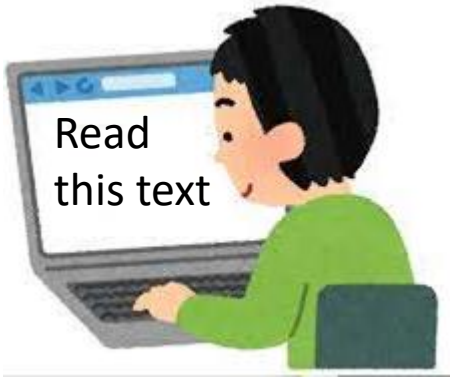
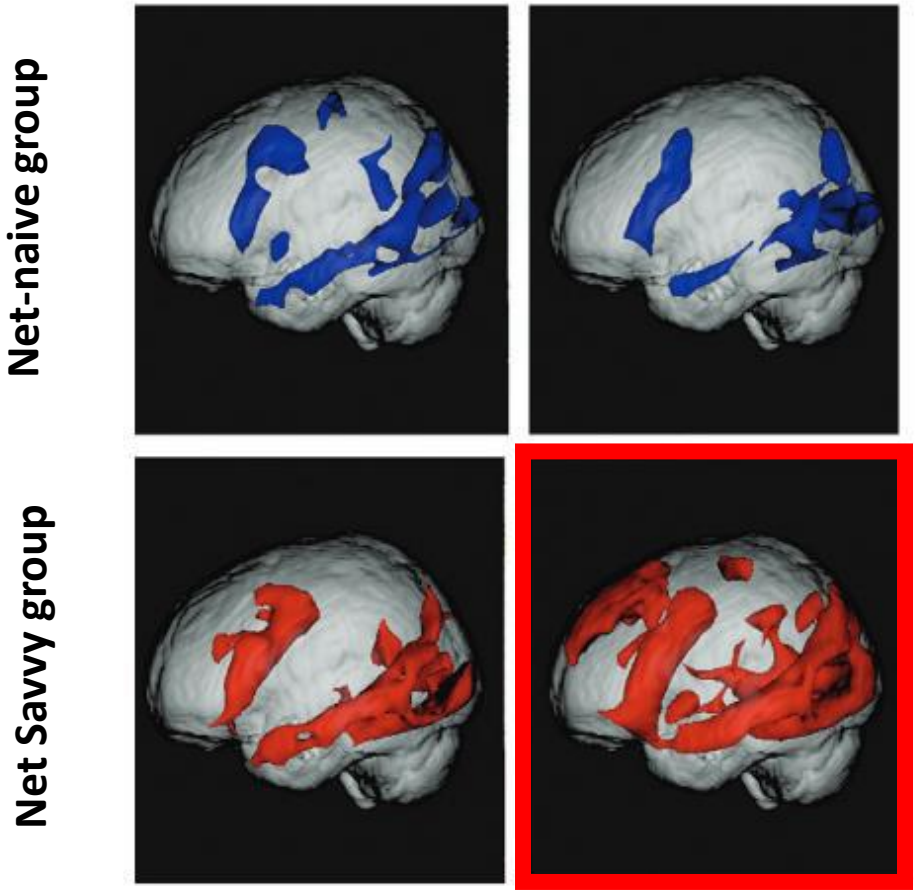
While the brains of the two groups showed similar patterns of activation during the text reading task…



…the activation patterns were markedly different during the Internet search task

Googling

- The brain scans of the Net-naive group showed an activation pattern similar to that of their text reading task.
- Net-savvy group demonstrated significant increases in activity in additional regions that control decision making, complex reasoning, and vision
- After only five days of spending a few hours on the Internet, the erstwhile naive group was showing brain activation patterns similar to those of their savvy counterparts



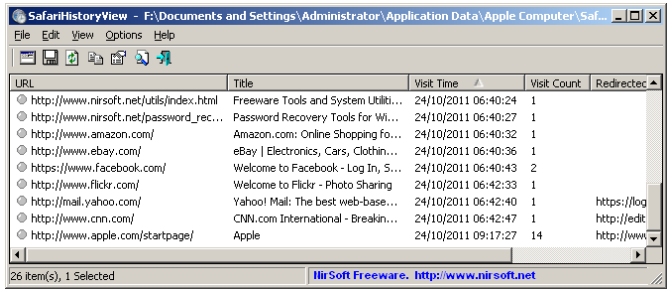
When we search information we organize facts

Highlight concepts

Connections between facts

Create maps

History



Audio

Videos

Key words

Hyperlinks

Internet exploration

Computers in Human Behavior 29 (2013) 694–705

Contents lists available at SciVerse ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

Internet exploration behaviours and recovery from unsuccessful actions differ between learners with high and low levels of attention ☆

Malinda Desjarlais *

Brock University, 500 Glenridge Ave., St. Catharines, Ontario, Canada L2S 3A1

- As a type of hypermedia, the Internet combines graphics, audio, video, text and hyperlinks in an interactive and nonlinear environment.
- Users **must decide** how to find information, what information to read, which hyperlinks to follow and when to modify behaviours.
- Consequently, for the Internet to be a valuable resource, individuals typically must be autonomous and **active** in their learning.

Internet exploration

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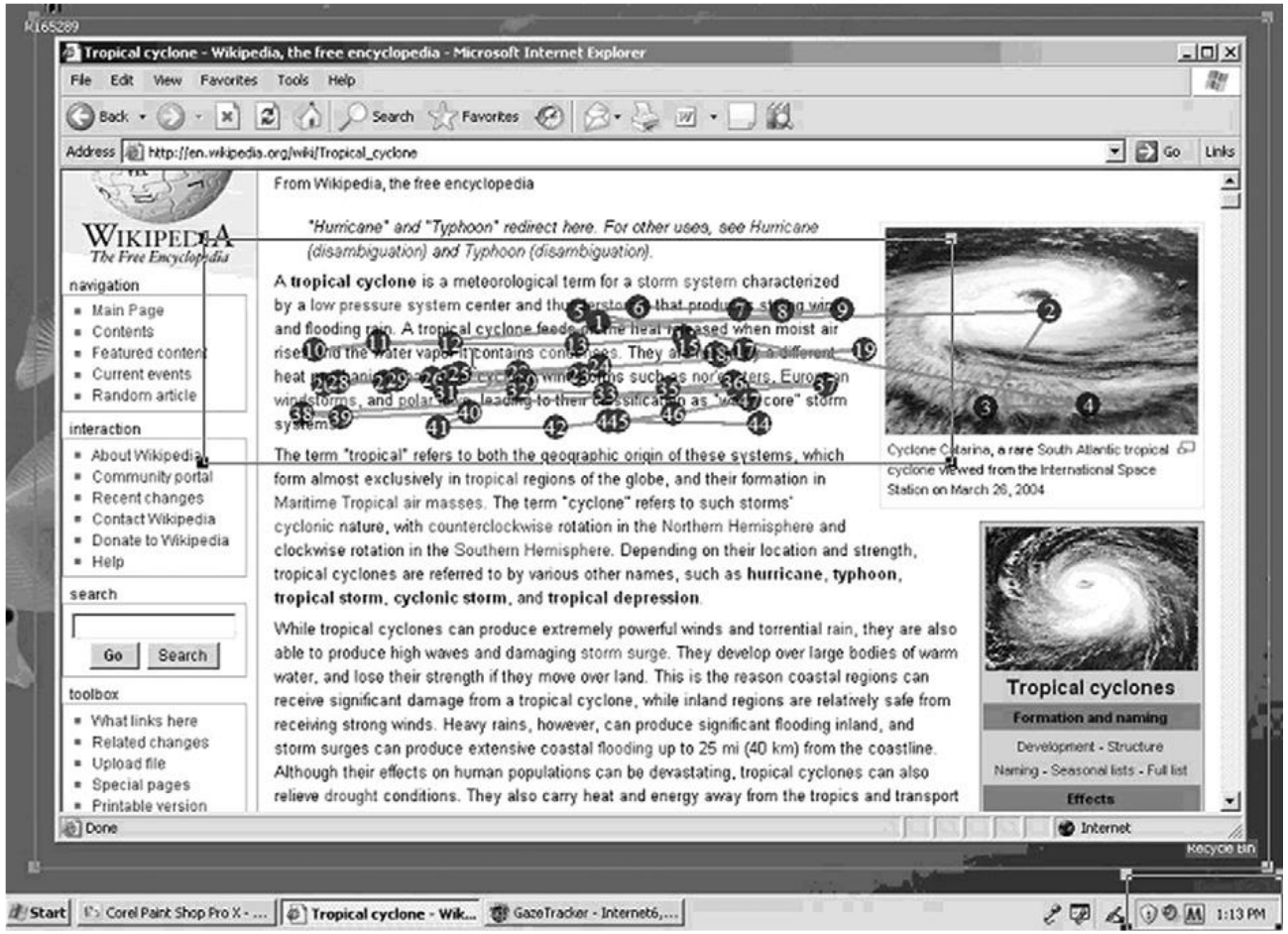
- Researchers have identified that learners with **low domain knowledge**, on average, have exhibited little or no learning gains after studying from hypermedia environments, including the Internet

- In general, attention has been regarded as a major influence on the information that is remembered; affecting entry, maintenance and retrieval of information

Internet exploration



- Eye-gaze was recorded
- Eye-gaze information was used to determine the time spent attending to relevant information.
- Based on the time spent viewing relevant look zones the following two scores were created:

(a) the duration of time spent within the look-zone during the initial visit of a particular link, and

(b) the duration of time spent within the same look zone during revisitation of the link

Internet exploration

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- N = 84 undergraduate students with high and low levels of sustained attention (65 females and 19 males, with a mean age of 20.46 years)

- Students were tasked with navigating the Internet for 20 minutes to learn about how tropical cyclones form

Internet exploration

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Internet exploration behaviours and recovery from unsuccessful actions differ between learners with high and low levels of attention ☆

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- Students with **high level of attention** → more frequently guided their learning in a linear manner, alternating between search engine results and first links. Rarely did these learners select hyperlinks presented on the links themselves, and it was these students who performed better on the test

Internet exploration

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- Learners with **low levels of sustained attention** → typically took advantage of the opportunity to jump around between sources of information. While they alternated between search engine results and first links, the low-attending learners engaged in far more exploration of the hyperlinks presented than the high-attending learners did. However, the hyperlinked sources were typically irrelevant. So, perhaps not surprisingly, those with short attention spans performed more poorly on the test than those who were able to focus longer

Internet exploration and generations

- Such variations in performance can be even more marked when we look across age groups

Google Generation II: web behaviour experiments with the BBC

David Nicholas, Ian Rowlands, David Clark and Peter Williams
CIBER, Department for Information Studies, University College London, London, UK

Google generation
(born after 1993)

Generation Y
(1973<born<1994)

Generation X
(born before 1973)

→ Younger generations were faster but less confident about the answers

Reading

Contents lists available at SciVerse ScienceDirect

International Journal of Educational Research

journal homepage: www.elsevier.com/locate/ijedures

Reading linear texts on paper versus computer screen: Effects on reading comprehension

Anne Mangen [a,*], Bente R. Walgermo [a], Kolbjørn Brønnick [a,b]

[a] The National Centre for Reading Education and Research, University of Stavanger, NO-4036 Stavanger, Norway
[b] Regional Centre for Clinical Research in Psychosis, Division of Psychiatry, Stavanger University Hospital, PO Box 8100, NO-4068 Stavanger, Norway

from books to screens

Readings

- The authors explored effects of the technological interface on reading comprehension in a Norwegian school context
- N = 72 tenth graders from 2 different primary schools in Norway.

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International Journal of Educational Research

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Reading linear texts on paper versus computer screen: Effects on reading comprehension

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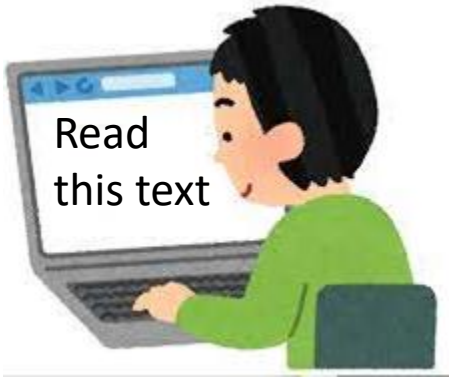
- Students randomized into 2 groups:

Read 2 texts (1400-2000 words) in print



Read the same text as pdf on a computer screen

Readings

- Regression analysis was carried out to investigate to what extent reading modality would influence the students' scores on the reading comprehension measure
- **RESULTS**: students who read texts in print scored better on the reading comprehension test
- Pedagogical implications?

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Readings

- This paper aims to assess the usability of electronic books (e-books) and paper books (p-books) with objective measures, including user comprehension, eye fatigue, and perception
- N = 56 sixth-year public school students participated in this study

A comparison of the influence of electronic books and paper books on reading comprehension, eye fatigue, and perception

Hanho Jeong
Department of Education, Chongshin University, Seoul, South Korea

Readings

A comparison of the influence of electronic books and paper books on reading comprehension, eye fatigue, and perception

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- Eye fatigue → Participants' eye fatigues were measured by critical flicker/fusion frequency (CFF) threshold.
- CFF is defined as the frequency at which a flickering light is in distinguishable from steady, non-flickering light
- CFF is widely used as highly sensitive measurement to evaluate retina functionality and it is an effective for assessing the eye fatigue

Readings

This paper was conducted in the following order:

1) pre-CFF measurement,
2) p-/e-book reading,
3) post-CFF measurement,
4) quiz and questionnaire.
5) exit

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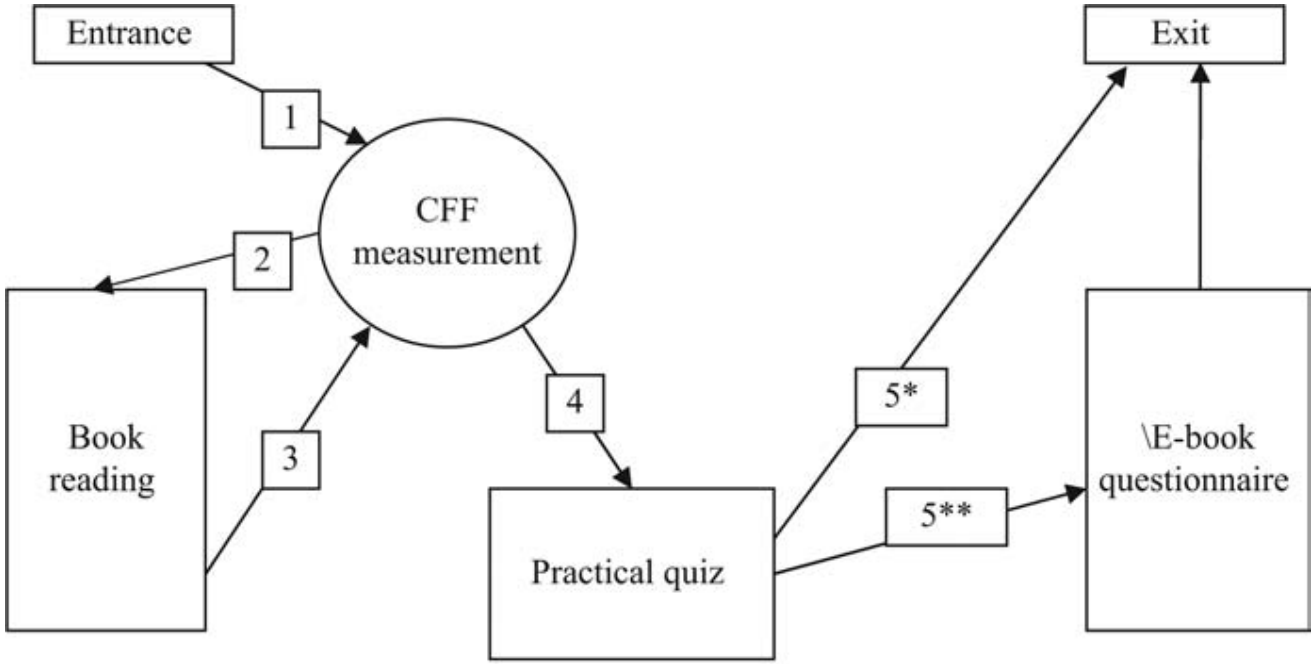

Notes: *After completing the p-book quiz; **After completing the e-book quiz

Readings

RESULTS:

1) there is a significant “book effect” on quiz scores → compared to e-books, p-books appear to enable better reading comprehension
2) Regarding eye fatigue, students had significantly greater eye fatigue after reading e-books than after reading p-books.
3) Students were satisfied with the e-book, but they preferred p-books.

A comparison of the influence of electronic books and paper books on reading comprehension, eye fatigue, and perception

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Multitasking

- A distinguishing feature of digital technology is the temptation and opportunity it offers for multitasking

- In a survey of two thousand children between the ages of eight and eighteen, the time spent multitasking between more than one technology medium in 1999 was 16 percent but had almost doubled to 29 percent ten years later.

Rideout, V. J., Foehr, U. G., and Roberts, D. F. (2010). Generation M2: Media in the lives of 8-to 18-year-olds.

Multitasking

- In a survey of U.S. college students, 38 percent said they could not go for more than **ten minutes** while studying without checking their laptop, smartphone, tablet, or e-reader
- Since media multitasking involves, by definition, shifting attention between multiple sources, much research has focused on how much information can be retained, and how efficiently, when individuals multitask between media

Kessler, S. (2011). 38 percent of college students can't go 10 minutes without tech [blog post]. Retrieved from http:// mashable .com/ 2011/ 05/ 31/ college -tech -device -stats.

Multitasking

Cognitive control in media multitaskers

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Edited by Michael I. Posner, University of Oregon, Eugene, OR, and approved July 20, 2009 (received for review April 1, 2009)

- Chronic media multitasking is quickly becoming ubiquitous, although processing multiple incoming streams of information is considered a challenge for human cognition.

- A series of experiments addressed whether there are systematic differences in information processing styles between **chronically heavy (HMMs)** and **light media multitaskers (LMMs)**.

Multitasking

PNAS

Cognitive control in media multitaskers

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- A trait media multitasking index was developed to identify groups of heavy and light media multitaskers.
- The questionnaire addressed 12 different media forms: print media, television, computer-based video (such as YouTube or online television episodes), music, nonmusic audio, video or computer games, telephone and mobile phone voice calls, instant messaging, SMS (text messaging), email, web surfing, and other computer-based applications (such as word processing).
- For each medium respondents reported the total number of hours per week they spend using the medium

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- The goal was to examine whether there is a relationship between chronic media multitasking and cognitive control abilities.
- Different hypothesis →

Positive

Light media multitaskers exhibit advantages in cognitive control

This result would motivate future work to establish whether heavy multitasking confers or reflects these advantages

Negative

Heavy media multitasking behavior is associated with deficits in cognitive control

This result would offer important prescriptive guidance irrespective of the direction of causality. If chronic media multitasking is the cause, then a change in multitasking behavior might be warranted

Multitasking

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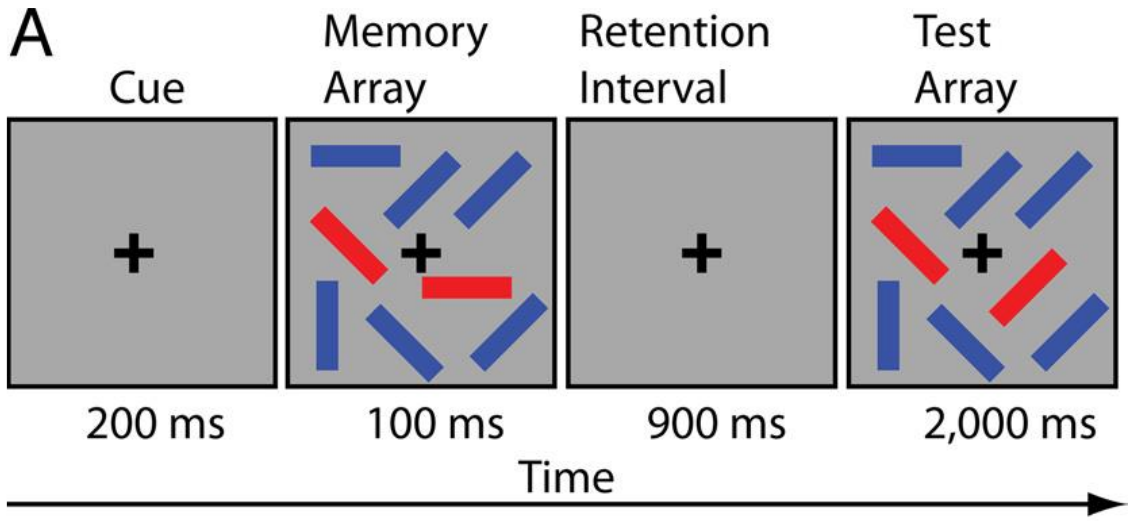
- Three tests in the study involved the subjects looking at shapes, numbers, or letters, but the task was to remember something about just some of the images on the screen and to ignore the others.



FILTERING TASK, example for shapes

Multitasking

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RESULTS:

Heavy media multitaskers are more susceptible to interference from irrelevant environmental stimuli

CONCLUSIONS:

the high multitaskers seemed unable to ignore the shapes they were told to ignore, and were unable to filter out what wasn't important to that particular task. In all cases the low multitaskers outperformed their high-multitasking counterparts